URANIUM-MINING OPERATIONS OF THE UTEX EXPLORATION CO. IN THE BIG INDIAN DISTRICT, SAN JUAN COUNTY, UTAH

BY CHARLES A. STEEN, GEORGE P. DIX, JR.,
SCOTT W. HAZEN, JR., AND RUSSELL R. MCLELLAN

* * * * * * * * * * **Information Circular 7669**

UNITED STATES DEPARTMENT OF THE INTERIOR
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J. J. Forbes, Director

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Charles A. Steen,[1] George P. Dix, Jr.,[2] Scott W. Hazen, Jr.,[3] and Russell R. McLellan[3]

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INTRODUCTION AND SUMMARY

Publication of this information circular results from an invitation extended to the Bureau of Mines by the Utex Exploration Co. to visit the company mine, on the Mi Vida claim about 39 miles southeast of Moab, in the Big Indian mining district, San Juan County, Utah. The Bureau is pleased to present this record of the Utex mine -- a property that in the relatively short period of 4 months has become one of the major uranium-ore producers on the Colorado Plateau.

The ore deposit was discovered in July 1952 by Charles A. Steen, a geologist-prospector, now chief geologist of the Utex Exploration Co., in the course of drilling the first diamond-core borehole in the Big Indian district. High-grade ore, 14 feet thick, was penetrated by the borehole. Sinking of a shaft, from which to develop the ore body, was begun in October, and the first shipment of ore left the property December 6, 1952. Ore production, as recorded on ore-settlement sheets received by the company up to July 15, 1953, totaled 16,000 tons averaging 0.51 percent U_3O_8 and 1.26 percent V_2O_5. Discovery of the ore body and the large production of ore were achieved without any financial assistance from the Government.

The Big Indian mining district is on the southwest flank of the Lisbon Valley anticline, which plunges to the northwest; the ore-bearing horizon is overlain by a considerable thickness of Jurassic and Cretaceous sediments. In the area the Chinle formation consists of variegated mudstones and siltstones, intraformational conglomerates, and fine- to medium-grained cross-bedded sandstones. The ore-bearing unit, in the Chinle formation, contains fossil flora replaced by pyrite or uraninite or preserved as carbon. Throughout the region carbon has played an important role in concentrating uranium. Two theories as to ore deposition have been expressed, the channel theory and the anticlinal theory.

As soon as the large size of the ore body became apparent, an inclined adit large enough to permit use of mechanical haulage underground was driven to the ore body from a point about 400 feet southeast of the shaft. The adit was completed in May 1953 and is used jointly by the Utex Exploration Co. and the G & G Mining Co., which holds a lease on a 200-foot segment across the 600-foot width of the Mi Vida claim.

The ore is 10 to 23 feet thick, and a modified room-and-pillar method of mining is employed. Ore is loaded underground with shovel loaders into a diesel truck by the Utex Co. and into a trailer by the lessee company for transport to a stockpile on the surface. From the stockpile the ore is moved by trucks to ore-buying stations at Monticello and Thompson, Utah, and Grand Junction, Colo.

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Settlements for the ore are made by the purchasing companies on the basis of the price schedule, bonus, and allowances set forth in Revised Circular 5 issued by the Atomic Energy Commission.

ACKNOWLEDGMENTS

Many members of the respective staffs of the Utex Exploration Co., the G & G Mining Co., and the Bureau of Mines contributed to the preparation of this information circular. Special acknowledgment for their courteous cooperation is due Dan O'Laurie, president; Allan P. Darby, assistant to the president; Oren L. Moore, mine superintendent; William A. Wood, underground foreman; and Mitchell Melich, general counsel, of the Utex Exploration Co., and Joseph N. Trudgeon, underground foreman of the G & G Mining Co.

Photographs reproduced were taken by H. K. Thurber, Jr., of the Mining Division, Region IV, Salt Lake City, Utah. H. D. Keiser, of the Bureau's Rare and Precious Metals Branch, Washington, D. C., assisted materially in coordinating the information presented in this circular.

LOCATION AND PHYSICAL FEATURES

The mine of the Utex Exploration Co. is 39.1 miles, by road, southeast of Moab, Utah, on the Mi Vida claim, in the Big Indian mining district, and in sec. 11, T. 30 S., R. 24 E., Salt Lake Meridian, San Juan County, Utah. Access to the mine is 22 miles southeast from Moab by U. S. Highway 160, 7.7 miles east by Utah State Highway 46, 5.4 miles southeast by county gravel road, and 4 miles generally south by winding dirt road. The mine can also be reached by traveling 32 miles southeast from Moab on U. S. Highway 160 and then 8.8 miles generally northeast on a winding dirt road up Steen Canyon; this road is used by trucks transporting ore from the mine. (See figs. 2 and 5.)

Topography of the area is typical of the semidesert Colorado Plateau region, comprising a series of anticlines and synclines with the drainage forming steep-walled canyons and mesas capped locally by massive cliff-forming sandstone. Vegetation is sparse and limited to scrub pine, pinon, and sage brush. The climate is arid, with temperatures rising above 100° F. in the summer and falling to below freezing in the winter. Snows are usually about 6 inches deep but occasionally reach a depth of 2 feet. Dirt roads to the mines in the area are passable throughout the year, except after severe storms and during spring thaws.

HISTORY

Early in 1951 Charles A. Steen, a geologist prospecting for uranium, staked 12 adjoining claims in the Big Indian mining district along the southwest flank of the Lisbon Valley anticline (see fig. 3). These claims, the Mujer Sin Verguenza, Mi Corazon, Besame Mucho, Pisco, Fundadoro, Te Quiero, Mi Vida, Linda Mujer, Mi Amorcita, Ann, Bacardi, and Mi Alma, comprise the property of the Utex Exploration Co.

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Figure 1. - General view of upper Steen Canyon showing surface plant at Utex mine. Portal of inclined adit is directly behind truck in center.

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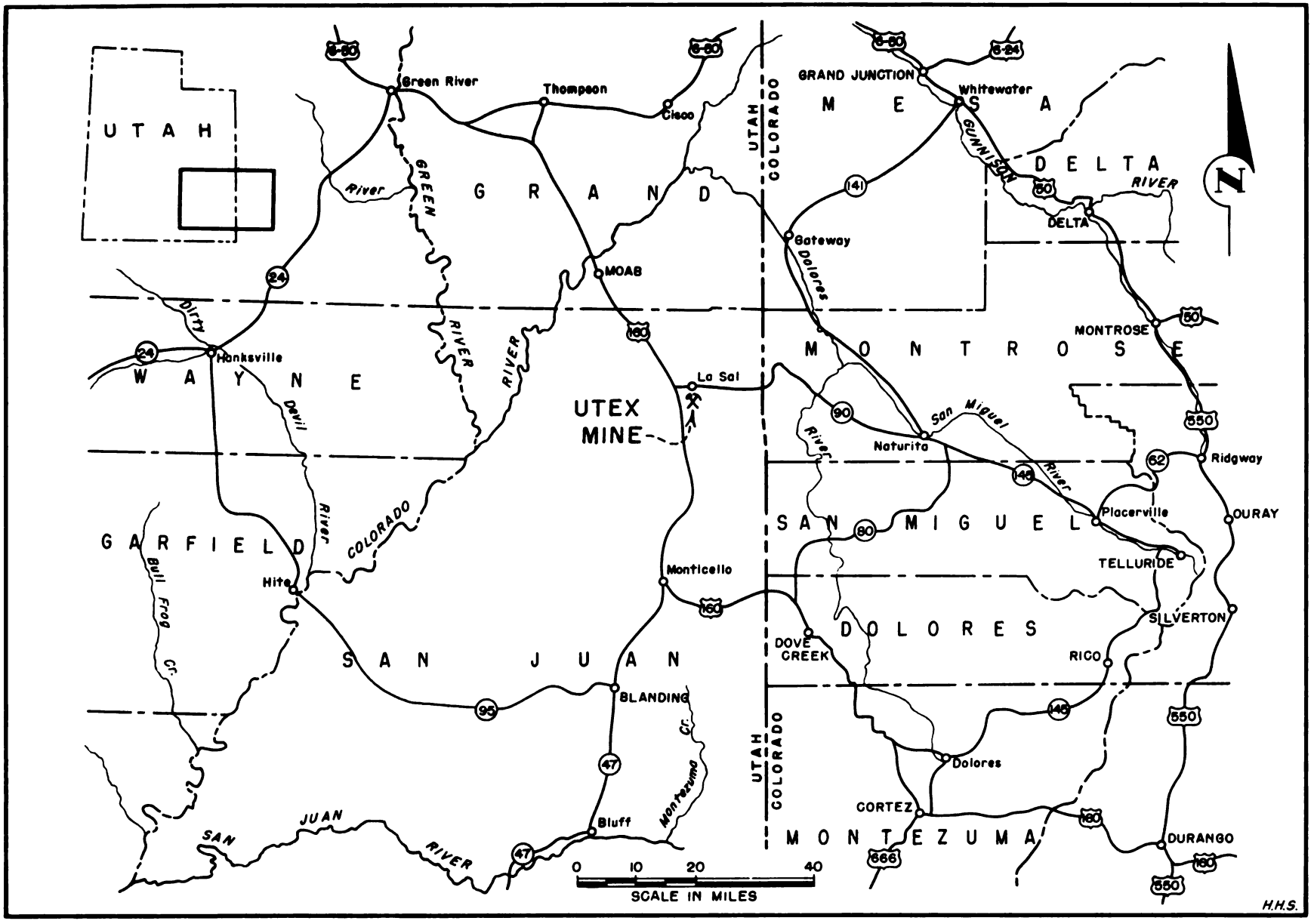

Figure 2. - Location map, Utex mine, Utex Exploration Company, San Juan County, Utah.

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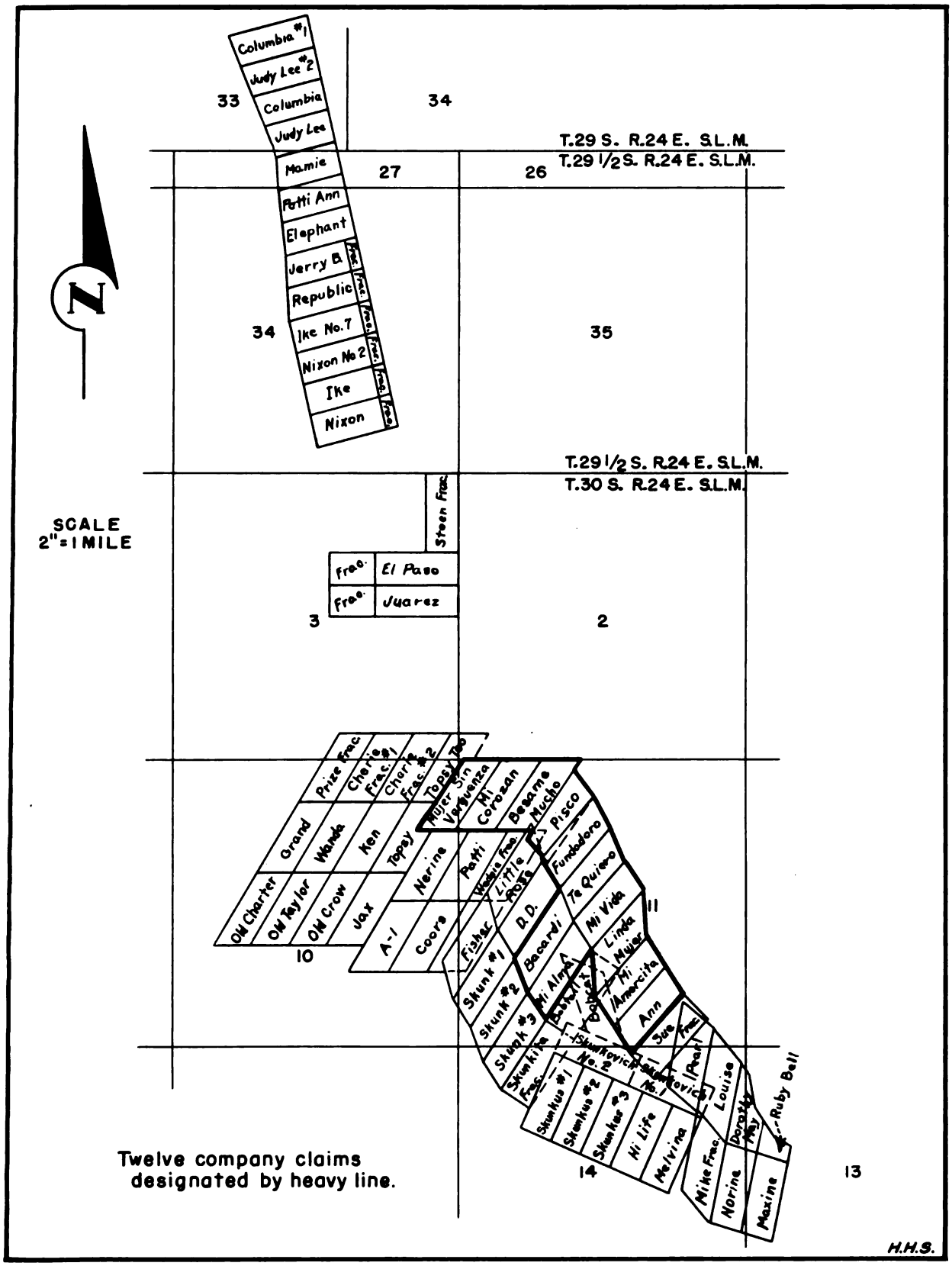

Figure 3. - Claim map showing Utex Exploration Company property, Big Indian mining district, San Juan County, Utah.

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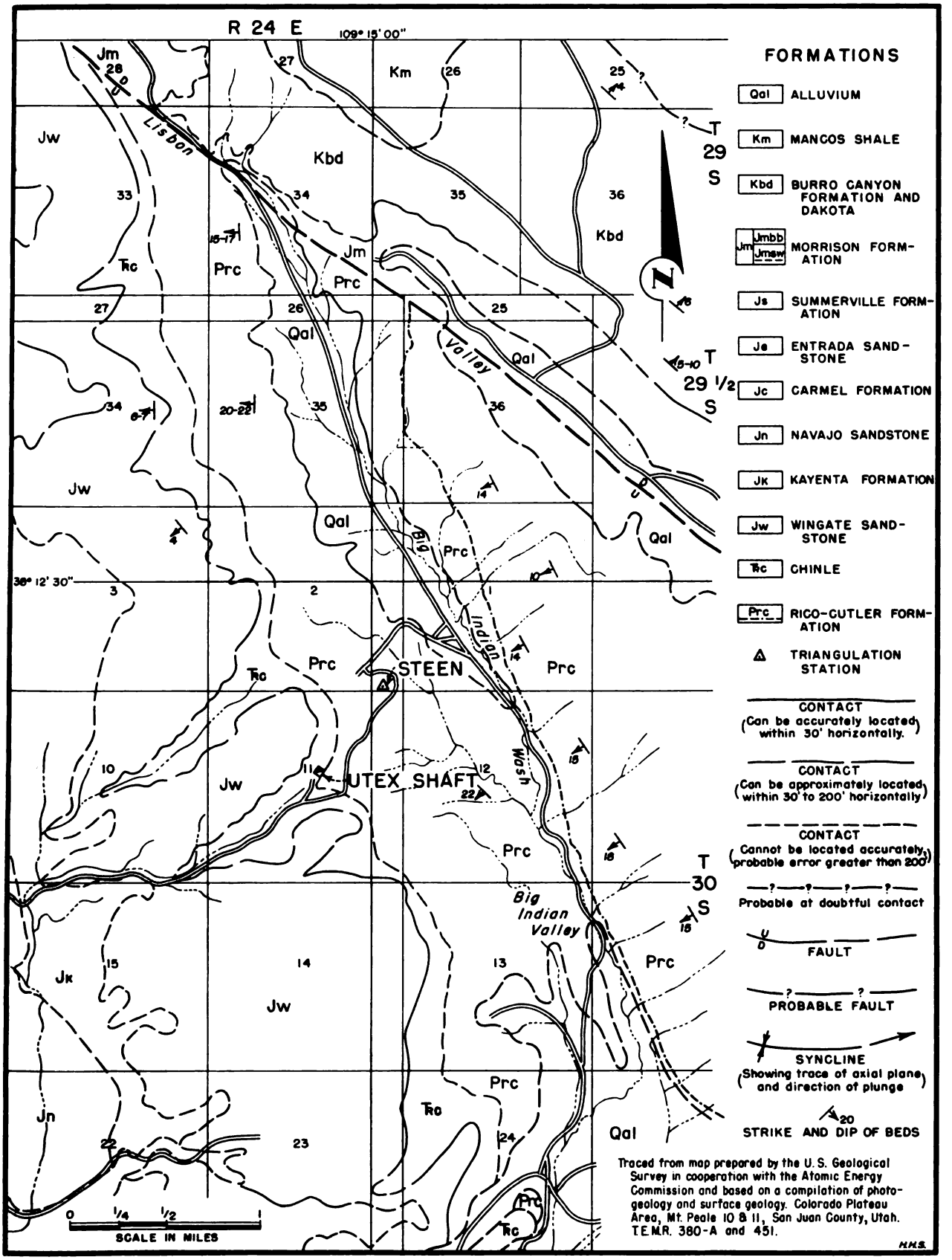

Figure 4. - Geologic map of Lisbon Valley and Big Indian Wash, San Juan County, Utah.

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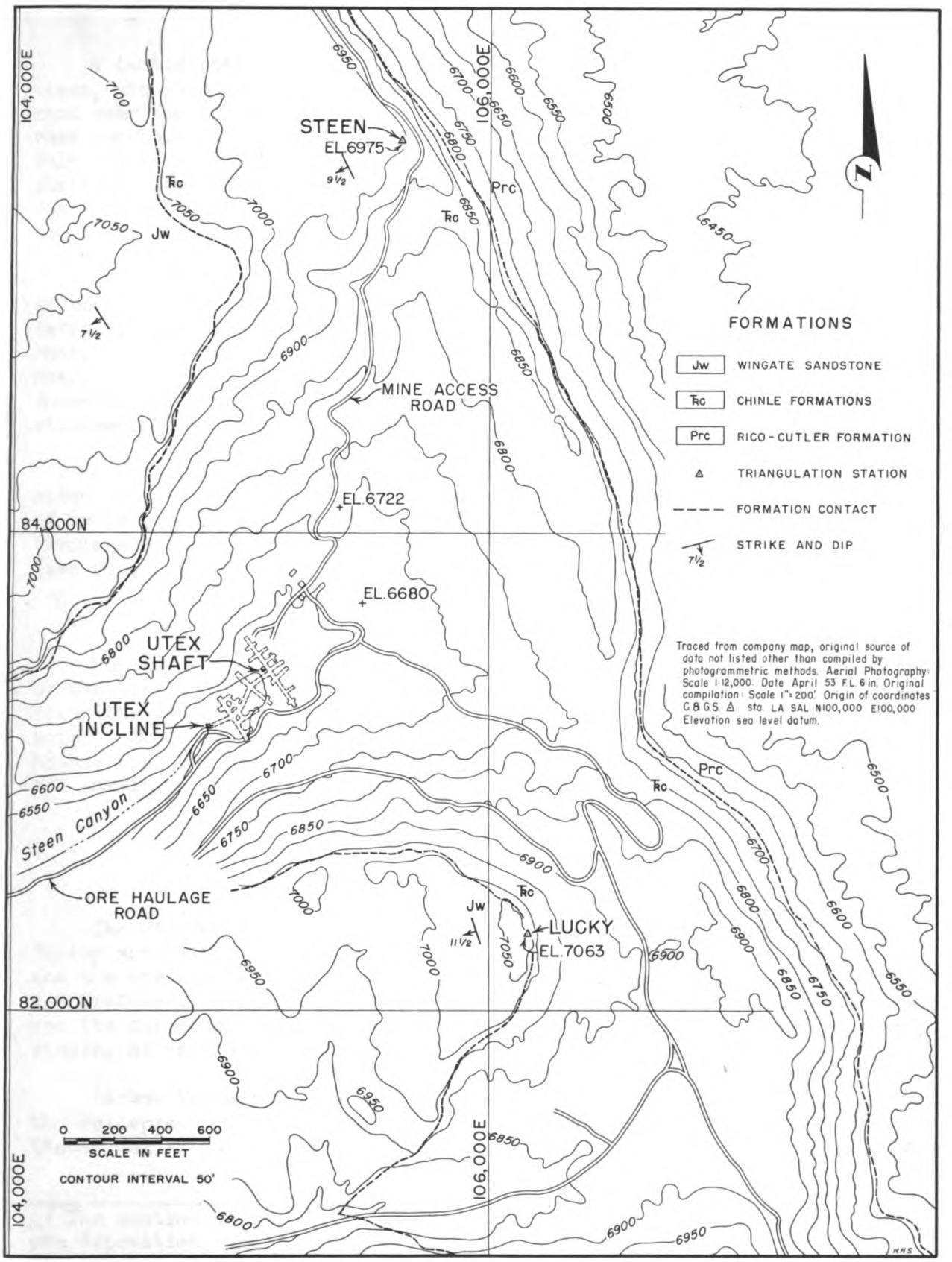

Figure 5. - Geologic map of Steen Canyon and vicinity, San Juan County, Utah.

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A 4-mile road from the county gravel road was built into the property by Steen, who then moved in a drill rig and, on July 3, 1952, at the end of the road near the middle of the Mi Vida claim, began drilling the first diamond-core borehole in the district. The borehole encountered rich uranium ore on July 6 at a depth of 70 feet and continued in ore for 14 feet. Sinking of a shaft, 30 feet southeast from the discovery borehole, began on October 4. The first ore was hoisted on December 4. Ore shipments from the mine were begun on December 6, 1952.

The Utex Exploration Co. was formed on October 24, 1952, with Dan O'Laurie, of Moab, Utah, president; W. T. Hudson, Casper, Wyo., vice president; R. M. Barrett, Moab, Utah, vice president in charge of operations; Charles A. Steen, Moab, Utah, secretary-treasurer and chief geologist; and Mrs. Rosalie Shumaker, Moab, Utah, assistant secretary-treasurer. Steen and his mother, Mrs. Rosalie Shumaker, hold a 51-percent stock interest in the company. Mitchell Melich, attorney, Moab, Utah, is general counsel of the company.

A 2-year lease, dated February 11, 1953, was executed by the Utex Exploration Co., as lessor, with Archie Garwood, R. C. Gerlach, and W. E. Bozman, of Cortez, Colo., as lessees, who operate as the G & G Mining Co. The lease involves a 200-foot segment across the 600-foot width of the Mi Vida claim (see fig. 6).

LABOR AND LIVING CONDITIONS

Bunkhouse facilities and board at the mine are furnished without charge by the Utex Exploration Co. to its mine employees. Most of the employees spend the weekends in Moab, Utah, with their families where they maintain homes. Employees of the lessee, G & G Mining Co., live in their own trailer houses near the mine on a site provided by the Utex company. Labor supply and working conditions are good; labor turnover is low.

GEOLOGY[4/]

Structure

The Big Indian mining district is on the southwest flank of the Lisbon Valley anticline. (See figs. 4 and 5.) The anticline plunges northwest, and the ore-bearing horizon plunges under a considerable thickness of Jurassic and Cretaceous sediments. The Lisbon Valley anticline is a salt structure, and its subsequent collapse is thought to have been caused by solution and stoping of salt under the crest of the anticline.

Lisbon Valley, to the east of the Big Indian mining district, rests on the collapsed portion of the anticline. Separating Big Indian wash from Lisbon Valley is the Lisbon Valley fault. It is a normal fault that strikes

4/ The section on geology, with the exception of the anticlinal theory of ore deposition, was prepared by George P. Dix, Jr., field geologist of the Utex Exploration Co. Charles A. Steen, chief geologist of the company, presents the anticlinal theory.

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northwest-southeast, paralleling the axis of the anticline. The displacement resulting from the fault has placed the Hermosa limestone (Pennsylvanian) against the Dakota sandstone (Cretaceous). The fault zone is mineralized with copper.

The Hermosa limestone escarpment on the east side of Big Indian wash dips 22° southwest. Across the wash the cliffs dip 15° southwest. Three miles west of this point the southwest dip decreases, and the beds become horizontal.

Stratigraphy

The formations in the Big Indian mining district range from Upper Pennsylvanian to Upper Cretaceous, but formations younger than the Wingate sandstone and older than the Cutler are irrelevant to this discussion. The formations making up the west escarpment of Big Indian wash are the Cutler (Permian), Chinle (Triassic), and Wingate (Jurassic). Uranium mineralization is found in both the Cutler and Chinle formations.

The Cutler formation in the area consists of fine sandstone, discontinuous lenses of coarse-grained arkosic sandstone, siltstone, and mudstone. It is essentially a red-bed unit. The source of the Cutler is generally considered to be to the east, and the Cutler becomes coarser from west to east. The coarse arkosic sandstone units contain granite, orthoclase, and quartz pebbles in abundance. They are mineralized with uranium and vanadium in the form of concretions and fine disseminations. No fossil wood nor carbon is found in the Cutler formation in this district.

The Chinle formation in the area consists of variegated mudstones and siltstones, intraformational conglomerates, and fine- to medium-grained, crossbedded sandstones. The upper part of the Chinle is chiefly a red-bed series of mudstone, siltstone, and fine-grained sandstone. Silicified fossil wood abounds in the upper part of the Chinle. The ore-bearing unit contains fossil flora replaced by pyrite or uraninite, or preserved as carbon. The Chinle formation is distinguished from other formations by its variable color and content.

The Moenkopi and Shinarump formations are not present in outcrops in the immediate vicinity of the operations of the Utex Exploration Co. In places throughout the region, the Moenkopi was completely eroded from the crests of structural upwarps before the overlying rocks were deposited (McKnight, 1940). The Shinarump conglomerate is absent due to nondeposition or subsequent erosion. It is known, however, that the Shinarump pinches out to the west in Indian Creek. The post-Cutler and post-Moenkopi unconformities are significant in explaining the absence of the two formations.

A question arises over whether or not the uranium-bearing conglomerates, sandstones, siltstones, and mudstones placed in the Chinle formation are actually the Shinarump conglomerate. McKnight describes the Shinarump as bearing pebbles of well-rounded quartz, quartzite, and

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chalcedony. Other workers describe the Shinarump as being a basal conglomerate overlying the Moenkopi formation. In the Big Indian mining district the conglomerates are limestone conglomerates with siltstone and mudstone pebbles. The lithology is identical to that of the Lower Chinle. Also the ore-bearing unit is not a basal conglomerate but is underlain by Chinle siltstone and mudstone units.

Theory of Ore Deposition

Channel Theory

The continuity of mineralization in the Lower Chinle has been projected by mining and drilling operations for approximately 3 miles from a rim outcrop south of the Big Buck 11 claim (which adjoins the Ruby Bell claim on the north; see fig. 3) to the Mamie claim in the northern part of the area. The trend line runs roughly from the rim outcrop of the mineralized zone to the Utex mine on the Mi Vida claim on a bearing of N. 30°-35° W. North of the mine the trend continues for one-half mile on that bearing and turns gradually to a bearing of N. 20° W. To connect the rim outcrop with the Mamie claim, mineralized drill holes are on the Sue Fraction, Ann, and Linda Mujer claims and the Utex mine on the Mi Vida claim. North of the mine are drill holes on the Fundadora, Pisco, El Paso, and Mamie claims. It is hypothesized that the trend is the axis of a Chinle channel.

Evidence of a channel and scouring is abundant. Lineation gathered from crossbedding, ripple marks, and streaming indicates that the axis of the channel is approximately N. 30° W. It is also evident that there is an abrupt thickening of the ore-bearing unit around the Utex mine on the Mi Vida claim. On the Fundadora and Pisco claims a fence of drill holes cuts the trend normal to the axis. There was a difference in elevation of the Cutler-Chinle contact of more than 50 feet in 100 feet of lateral distance after correction for dip. In other words, there was a 50-foot scour into the Cutler formation and a thickening of the ore-bearing unit. The lithology in the vicinity of the channel axis supports the channel theory. There are crossbedded sandstones and poorly sorted conglomerates that suggest swift water. Carbonaceous trash abounds along the axis. East and west of the channel axis thick beds of siltstone and mudstone are found, and the ore-bearing unit is thin.

It is not suggested that the uranium concentrated in the channel was detrital. Rather, the channel, with its porous sandstone and poorly sorted conglomerate and variable lithology was a favorable host for later uranium solutions introduced into the Chinle formation. The abundance of carbon to trap and precipitate uranium from mineralizing solutions is another favorable element. Throughout the region carbon has played an important role in concentrating uranium. In the Utex mine uraninite of 87.55 percent U_3O_8 was found to replace vegetal trash. The variable lithology of a channel provides favorable traps for uranium solutions, and uranium is often concentrated in a permeable unit between two impermeable units. The rock underlying the scour is impermeable siltstone and mudstone and would tend

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to reduce abruptly downward migration of mineralizing solutions. It is apparent that the mineralizing solutions have been selective. In the Utex mine there is a large concentration; in other parts of the channel the mineralization is weak, but is continuous along the trend.

The origin of the mineralizing solution remains obscure. The solution could have been either ground water or a hydrothermal solution. Uraninite has been synthesized at 50° C. and can be made at a lower temperature in the presence of pyrite. Pyrite is found in close association with uraninite in the Utex mine. It is then apparent that the mineralizing solution could be either hot magmatic water from the nearby La Sal Mountain laccolith or ground water. The Lisbon Valley fault is an unlikely source for uranium solutions because it contains abundant copper in the fault zone, and there is only a minute amount of copper in the Utex mine. Ground-water activity is in evidence throughout the mine. It has migrated along fractures, sometimes creating vugs in mudstone. The fracture planes and vugs are coated with tyuyamunite. This ground-water action is very recent, however.

In summary, the channel theory is suggested by thickening of the ore-bearing unit and scouring into the underlying Cutler formation. The channel provides a favorable host for the mineralizing solution. Carbon plays an important role in concentrating uranium. The mineralizing solution was either hydrothermal or ground water or possibly a combination of the two.

Anticlinal Theory

The most disputed point relative to the uranium deposits of the Colorado Plateau is: When and how did these deposits reach their present location? There is no doubt about a real lack of research from which an intelligent answer to this question may be evolved.

One hears about a detrital origin from a large land mass containing traces of uranium; about surface waters carrying uranium in solution to an environment where an effective precipitant was present; about relations to the large late-Cretaceous to early-Tertiary intrusive masses of the Plateau region. The writer (Charles A. Steen) believes that the last-mentioned concept accounts for the origin of the uranium deposits, no matter where and how they are now found. Age determinations made recently argue against the ore bodies being contemporaneous with deposition of the host sandstones.

All ore bodies with which the writer is acquainted show that structures favorable for oil reservoiring played an important role in localizing the uranium of the Colorado Plateau. The Temple Mountain and Big Indian areas are good examples. The writer knows of no ore deposits, nor has he heard of any, occurring in synclinal areas. All deposits with which he is acquainted are well up the flanks of monoclines and anticlines. The greatest concentration of ore in the Utex mine, Big

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Indian area, is 1,500 feet down dip from the rimrock, in basal sandstones of the Triassic Chinle formation that are conglomeratic in many places. Width of the ore dipwise is 1,000 feet plus. At the mine, elevation of the top of the ore body is 6,585 feet and elevation of the bottom 6,570 feet. On the Mamie claim, 3 miles northwest of the Utex mine, the elevation of the top is 6,538 feet and that of the bottom 6,520 feet. Other smaller ore deposits have been found at the same elevation on the flank of the anticline. This indicates that the ore body follows the strike of the beds along the flank. The fact that the majority of uranium claims are in areas covered by oil leases is significant.

Nearly all, if not all, of the important uranium deposits are found in the fresh-water deposits of the Morrison (Upper Jurassic) and the Chinle (Lower Triassic). These formations were deposited at a time of heavy vegetation and abundance of animal life. Why did the uranium solutions lose their uranium here and select such beds as a host?

MINERALOGICAL DATA

Five selected samples, taken from different areas of the mine, were forwarded to the Bureau of Mines Metallurgical Division, Salt Lake Experiment Station, Salt Lake City, Utah, for mineralogical study. Results of spectrographic and microscopic examinations of the samples follow:

Spectrographic Examination

Spectrographic results show that all five samples contain Na, K, Cu, Mg, Ca, Al, Ti, Si, Pb, V, U, Mn, Fe, a trace of Ga, and a trace of Ni. In addition, sample 1 contains Te, Zr, and Mo. Sample 2 contains traces of Zr, Mo, Te, and Co. Sample 3 contains traces of Zr, Mo, and Te. Samples 4 and 5 contain traces of Zr and Mo.

Microscopic Examination

Microscopic examination[5/] of the five samples shows that the host rock in each is sandstone composed chiefly of rounded quartz grains and small amounts of microcline and other minerals. The uranium and vanadium minerals occur in a cementing material between the grains. The two principal uranium minerals are the yellow tyuyamunite and the soft black or dark gray altered uraninite. The tyuyamunite contains vanadium; however, most of the vanadium occurs as a vanadium-aluminum silicate similar to an unnamed amorphous gray mineral found in other ores of the plateau, which has an index of refraction of 1.60 to 1.62. Vanadium also occurs in sample 2 as vanoxite in the form of black bladed crystals in the cementing material. A small amount of pyrite is present in all samples and a small amount of galena occurs in samples 2 and 5. A minor amount of purple fluorite, less than 1 percent, also occurs in all samples. The dark color of the samples is attributed chiefly to the dark uranium and vanadium minerals and not to carbonaceous material, since the organic carbon content of the samples is very low. Chemical analyses of the samples follow:

5/ By H. L. Gibbs, metallurgist, and E. G. Irwin, petrographer, Metallurgical Division, Region IV, Bureau of Mines, Salt Lake City, Utah.

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Sample No.	Percent			
	U_3O_8	V_2O_5	$CaCO_3$	Organic carbon
1	1.93	0.15	0.1	0.22
2	4.38	6.40	24.8	.35
3	2.81	5.80	.43	.14
4	.91	1.50	9.5	.48
5	11.1	2.4	31.4	.59

A description of each of the five samples follows:

Sample 1, taken in No. 2 drift west, 1 foot from the floor, is a dark-gray sandstone-type ore containing 1.93 percent U_3O_8, but differing from the other samples in having very little vanadium (0.15 percent V_2O_5). The sandstone is composed for the most part of rounded quartz grains loosely cemented together. It is estimated that 85 percent of the rounded grains are quartz, 10 percent are microcline feldspar, and the remainder is represented by small amounts of zircon (1 percent), tourmaline (0.5 percent), and apatite (1 percent). The sand grains cover a fairly long range of sizes, but most of the grains are between 48- and 100-mesh. The uranium in this sample is present as a soft, altered uraninite. It is dark gray and transmits greenish-gray light around the edges where the grains are thin. The index of refraction exceeds 1.74, and the mineral is isotropic. Strong, concentrated light did not reveal inclusions in these grains, although the centers are opaque. A few of these altered uraninite grains are as large as 65-mesh, although most of them are much smaller.

Sample 2, taken from a pillar in No. 2 drift west, 3 feet from the floor, contains uranium and vanadium minerals in a dark sandstone composed mainly of quartz grains, with some sulfide minerals and minor amounts of other minerals. The dark color of the ore is caused by the presence of considerable vanadium and uranium minerals found as part of the cementing material. The uranium mineral was tentatively identified as an altered dark-gray uraninite, which is extremely fine-grained. The vanadium is present as vanoxite, together with the previously mentioned unidentified vanadium-aluminum silicate mineral. The sandstone is composed mainly of rounded grains of quartz, with grains of muscovite, zircon, fluorite, pyrite, sphalerite, and galena all cemented together with calcite, uraninite, vanoxite, and the vanadium-aluminum silicate mineral. The unidentified vanadium silicate mineral has an index of refraction of 1.60, with low birefringence. A spectroscopic analysis showed that it contained aluminum and silica, with some calcium, magnesium, and sodium. This mineral was found mainly as cementing material and is minus-100-mesh in size.

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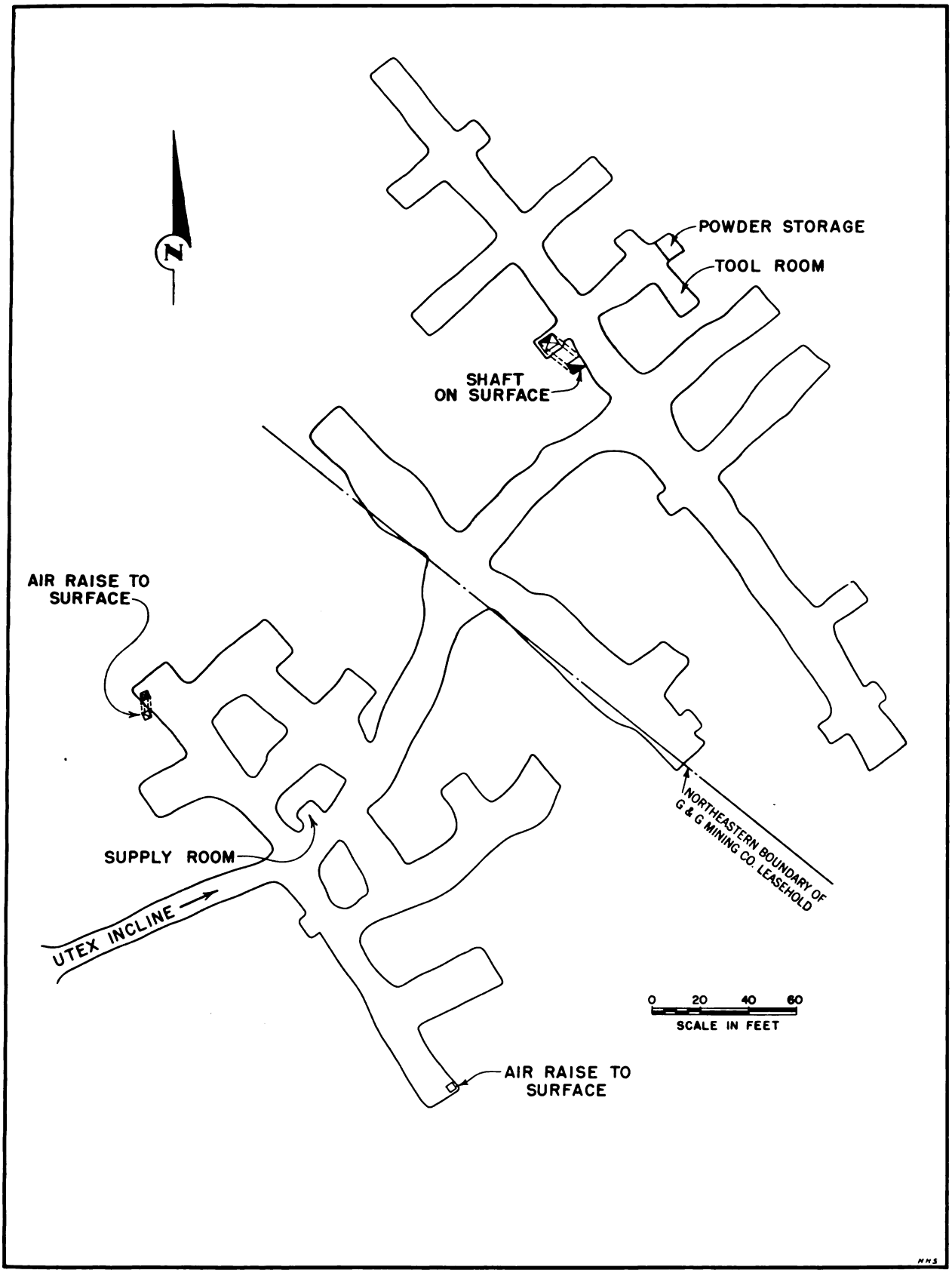

Figure 6. - Plan map, underground workings, Utex mine, San Juan County, Utah.

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Sample 3, taken from the north face of No. 2 drift east, 10 feet from the floor, is composed, megascopically, of a dark-brown sandstone, with bright yellow mineral between the grains of sand. Microscopically, this ore contains sand grains of quartz, feldspars, muscovite, zircon, and fluorite, cemented together with calcite and a vanadium-aluminum silicate mineral, tyuyamunite, and probably uraninite. The bright-yellow mineral is a calcium-uranium vanadate optically identified with the aid of chemical analysis as tyuyamunite. The sand grains, which are mainly quartz, compose approximately 70 percent of the sandstone. The cementing material comprises the remaining 30 percent and is chiefly the vanadium-aluminum silicate mineral, with included fine-grained uraninite.

Sample 4, taken from the base of a pillar in No. 1 drift west, is a light gray sandstone containing quartz, feldspars, muscovite, calcite, tyuyamunite, and minor amounts of hornblende, tourmaline, and apatite. Thin sections of this ore show that it is composed chiefly of quartz grains, mainly 65- to 100-mesh in size, cemented with calcite, tyuyamunite and the vanadium-aluminum silicate mineral. The uranium is mainly present as tyuyamunite.

Sample 5, taken in No. 1 drift west, 2 feet from the floor, is also a sandstone, which is dark brown to black and contains quartz, calcite, feldspars, galena, pyrite, fluorite, tyuyamunite, uraninite, and the vanadium-aluminum silicate mineral. Thin sections show that the uranium minerals, the vanadium-aluminum silicate, and the calcite are the cementing materials of the sandstone. The sand grains are chiefly quartz and feldspars ranging in size from 48- to 400-mesh. A polished thin section shows small grains of galena throughout the ore and a small amount of minus-600-mesh corroded pyrite grains. An X-ray powder pattern was made on a radioactive concentrate and the exposed pattern was that of uraninite. Uraninite is probably the main uranium mineral in this sample, associated with lesser amounts of tyuyamunite, the yellow calcium-uranium vanadate.

EXPLORATION AND DEVELOPMENT

Initial exploration was by diamond drilling on the Mi Vida claim, in Steen Canyon. After the first diamond-drill hole encountered ore, four additional holes were drilled to test the extent of the ore body.

Favorable results of exploration led to formation of the Utex Exploration Co. and plans for development of the ore discovered. An 8- by 8-foot timbered shaft, inclined 83° southeast, was begun in October; ore was encountered in the shaft at a depth of 70 feet in December 1952.

Mining operations from the shaft soon established the nature and apparent size of the ore body. Arrangements were then made looking toward development by an inclined adit large enough to permit the use of mechanical haulage underground. Under the terms of the lease executed with the G & G Mining Co., the lessee agreed to drive such an adit from a point about 400 feet southeast of the shaft to the ore body or productive horizon, and to continue the adit to the shaft. Driving of the adit, 10 by 10 feet in

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minimum cross section and at a downward inclination of 15°, was begun in March and completed in May 1953; it is used jointly by the Utex Exploration Co. and G & G Mining Co. for access and ore haulage.

Underground development is carried out by a modified room-and-pillar system with 50- and 100-foot intervals. Although headings are driven 12 to 15 feet high, ore remains in the back and bottom of the workings in certain places inasmuch as the thickness of the ore varies between 10 and 23 feet.

Additional exploration by diamond drilling has been accomplished by the Utex Exploration Co. on several of its claims. Most of this drilling has been in adjacent canyons or areas where depths to the ore horizon are at a minimum.

MINING METHODS AND MINE PLANT

The substantial width and thickness of the ore deposit have made feasible a modified room-and-pillar method of mining. With the exception of the driving of the inclined adit, all mining has been in ore and has not progressed beyond the stage of drifting; no rooms or stopes have been started.

Although thickness of the ore varies from 10 to 23 feet, drift headings measure about 12 by 12 feet in cross section. A drift round averages 50 holes, and 2 miners drill a drift round in 5 to 6 hours. Four miners are engaged in drilling ore. Six-foot drill steel is used, and the rounds break to a depth of 5½ feet, yielding about 60 tons of ore. Jackleg or pusher-type drills and Sandvick Coromant steel, with tungsten carbide chisel bits, are employed. Company experience has indicated that this steel is economical; although a new piece will break occasionally, 2,000 to 3,000 feet of drilling can be expected from each piece with proper care and grinding. Compressed air is delivered to the various mine headings through 3- and 2-inch pipelines that extend from the surface into the mine through the shaft and 6-inch-diameter boreholes. Water is piped underground by gravity through the shaft and boreholes.

One miner, employed specifically as a powderman, does all loading and blasting. Approximately 3 boxes or 150 pounds of 30-, 40-, or 45-percent dynamite are used to blast a drift round of 50 holes. Electric detonators, with delay intervals of 1 through 10, are used. The blasting circuit includes an underground safety switch near the shaft, and from there the main leads extend through a separate borehole to the blasting switch on the surface.

Broken ore is loaded underground with an International TD-9 tractor Loadover and then hauled to the surface and dumped on the ore stockpile with a GMC diesel-motor tandem truck. Both of these units, for underground use, are equipped with water scrubbers on the exhaust. An Inter-

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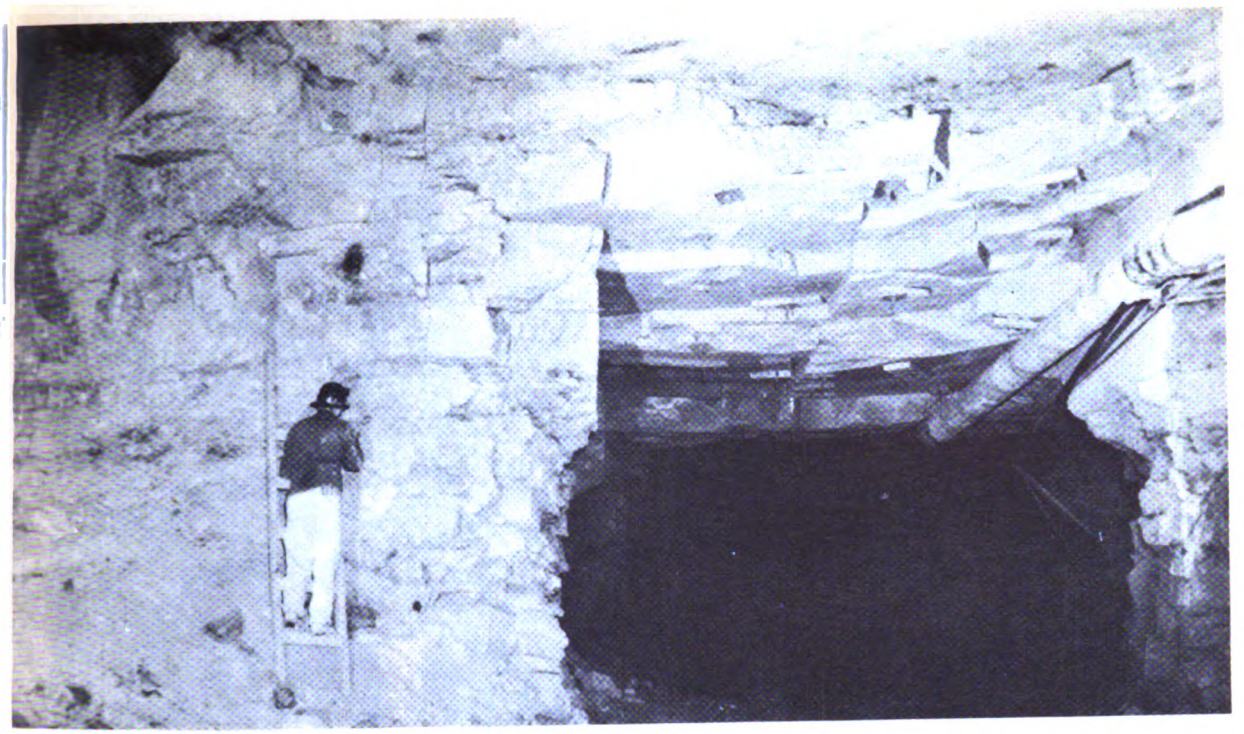

Figure 7. - Intersection of main haulageway and crosscut showing roof bolting and major fractures.

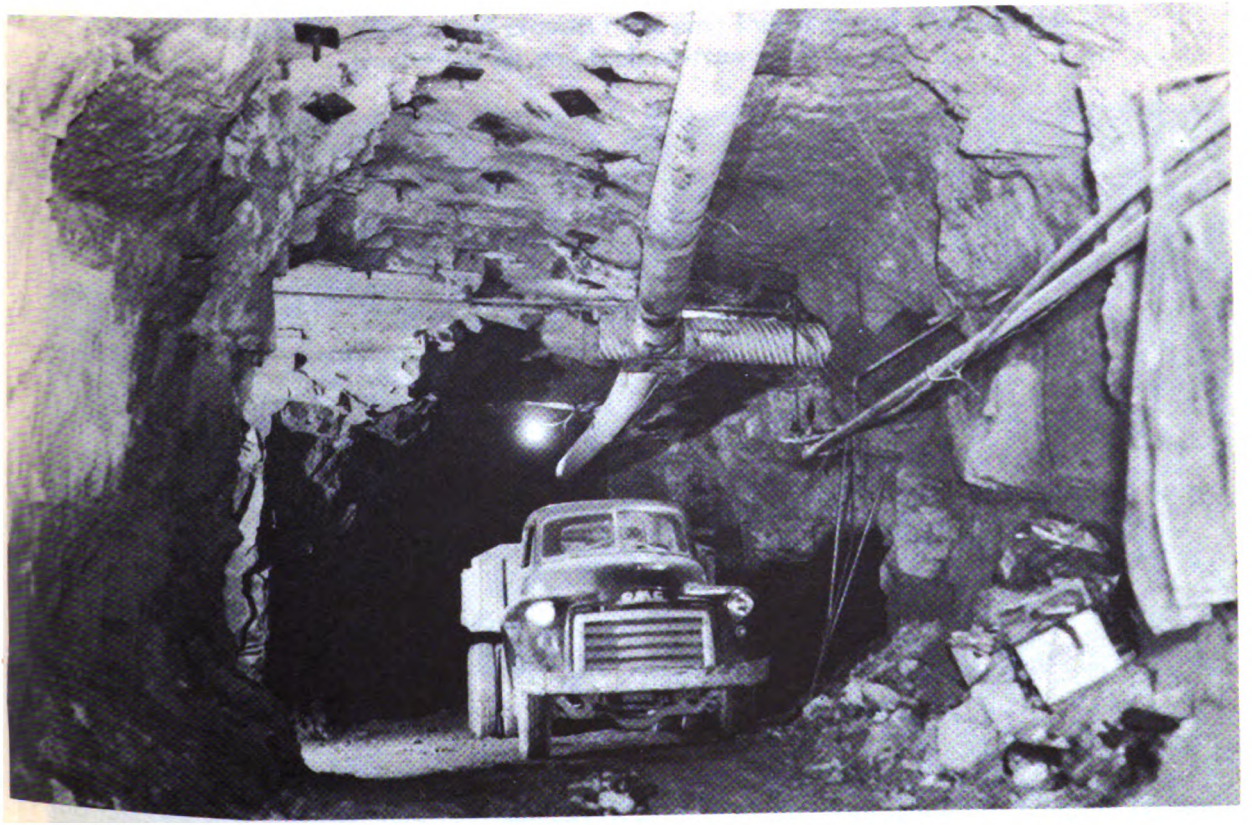

Figure 8. - Diesel truck used for underground haulage; closely spaced roof bolting; and ventilation piping.

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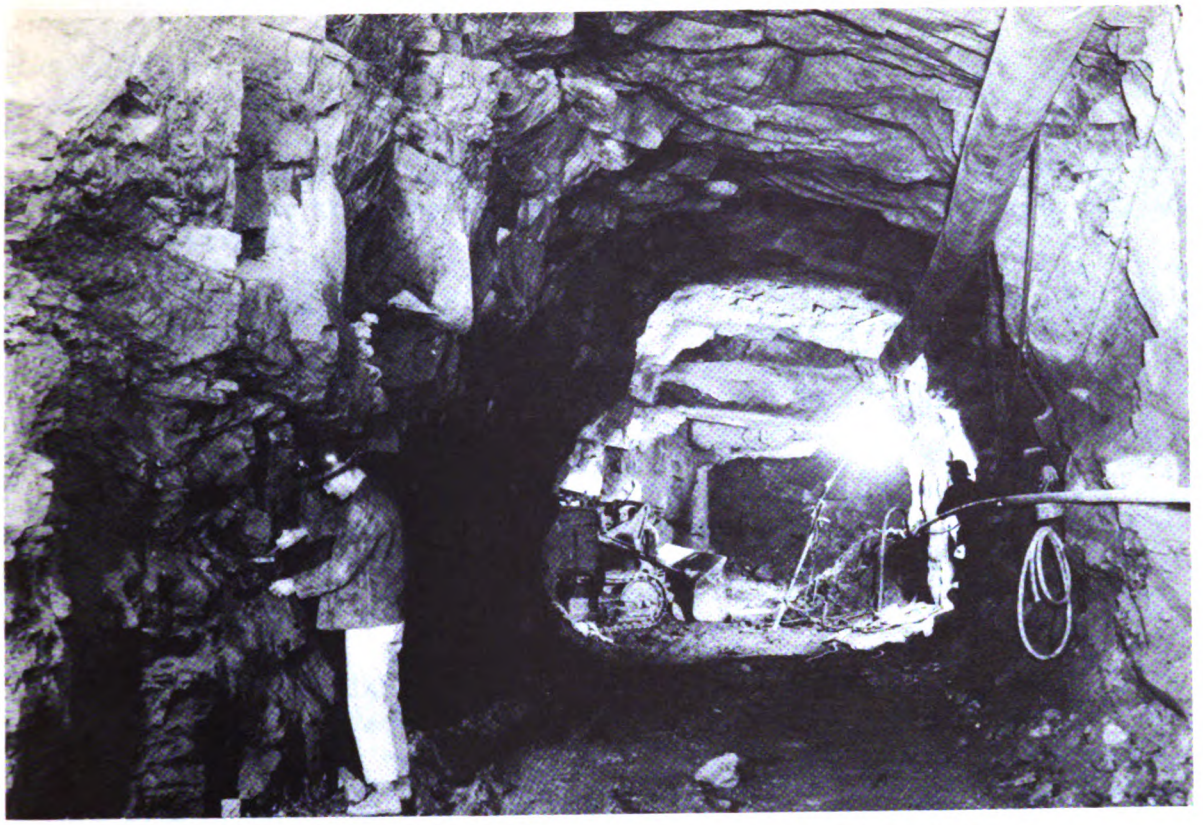

Figure 9. - View along crosscut showing International TD-9 diesel tractor loader and jackleg-type drill.

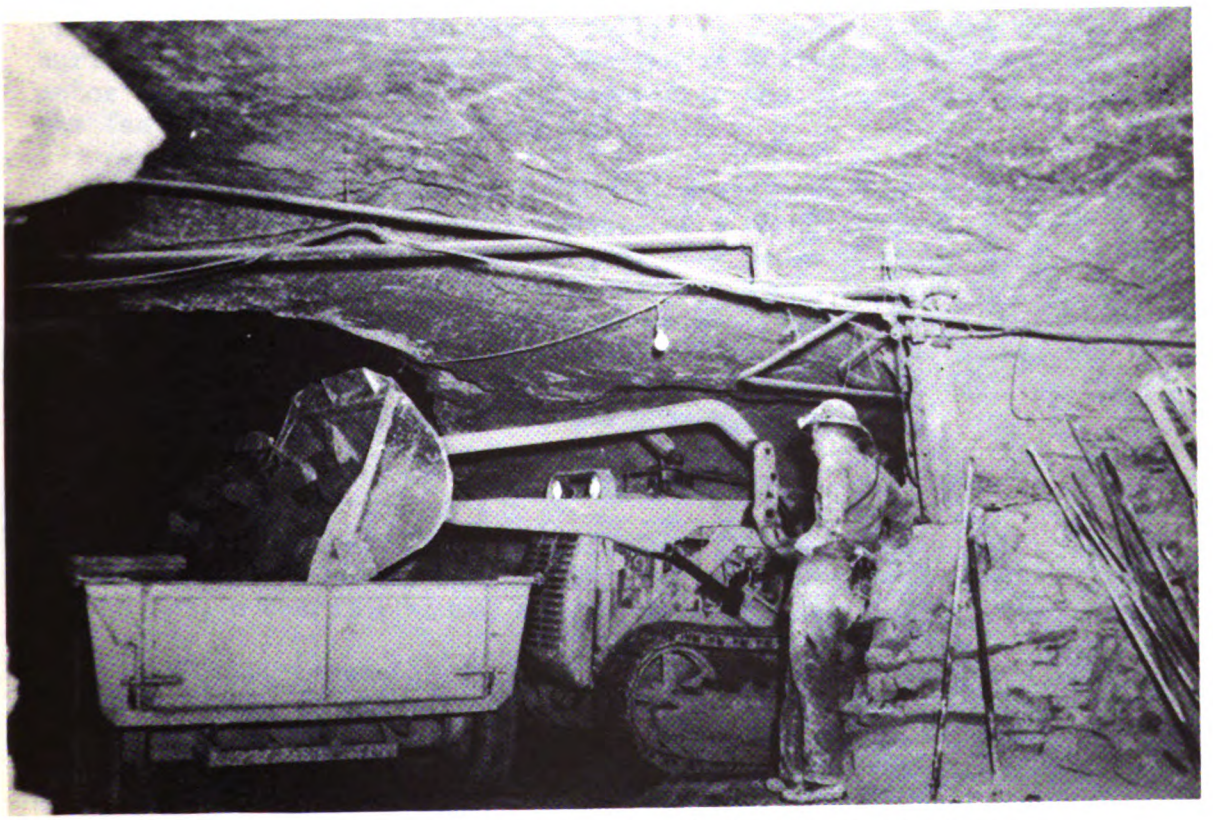

Figure 10. - Caterpillar HT-4 diesel with shovel loader discharging ore into trailer.

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national TD-9 tractor, with a Bucyrus-Erie dozer-shovel end loader, is used to load ore from the stockpile into trucks for transport to the ore-buying stations.

The mine shaft, which now serves only as a manway and pipeway and for the transport of supplies underground, is timbered; virtually no other timber is used in the mine. Roof bolts on a 4-foot spacing pattern are used in the backs of drifts, and their use is contemplated in future in the backs of rooms and stopes. In part of the mine a sandstone bed, 12 to 18 inches thick, lies directly above the ore; this bed, however, lenses out, and a nodular mudstone bed overlies the ore in the reaminder of the mine. The mudstone spalls around the roof bolts, requiring some resetting of bolts and the setting of additional bolts, operations that result in a more closely spaced pattern. Two miners are engaged in roof bolting throughout each shift.

Natural ventilation is provided by the inclined adit, the shaft, and two 4- by 4-foot raises driven to the surface from the ends of two development drifts in the south section of the mine. Forced-air ventilation is also provided from the surface through an 18-inch Hillcore metal-vent pipe that extends down the shaft from a Coppus Ventair TP-9 blower driven by a General Motors diesel engine. After the vent pipe reaches the mine level, its diameter is reduced to 12 inches and the piping extended into each of the main development drift headings. Recently a 42-inch-diameter, 4-blade, propeller-type exhaust fan was installed in a wooden housing erected on the surface over one of the raises. The fan is driven by a 3/4-hp. electric motor connected by a V-belt. A trapdoor in the housing prevents damage to the fan by concussion from blasting.

Mining operations of the G & G Co. are almost identical with those of the Utex Co., described above, except for a closer spacing of drifts (see fig. 6) and the method of hauling ore. The lessee company uses a Caterpillar HT-4 diesel with a shovel-loader and hauls the ore with a 2-wheeled trailer pulled by a Caterpillar D-2 tractor. The trailer, built locally, is equipped with 8.25- by 20-inch rubber tires and has a capacity of 4 tons. Ore is stockpiled on the surface and loaded into trucks with a Caterpillar D-4 traxcavator for transport to the ore-buying stations.

Surface Plant

In the relatively short period since its mining operations began, the Utex Exploration Co. has constructed a surface plant that includes 3 bunkhouses, a boarding house, modern change house, shop, and warehouse.

A 7.75-kw. generator driven by a diesel engine furnishes power for electric lights in all surface buildings and in the mine, as well as power for mine ventilation, for the charging panel for electric cap lamps, and for the walk-in cooler and refrigeration at the boarding house. It also provides electric lighting for employee-owned trailers at the mine.

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Water is piped to all buildings and underground from a 5,000-gallon, steel, water tank along the canyon side above the camp. Water consumption averages 2,000 gallons per day; water is hauled from Moab, Utah, in a 1,000-gallon tank truck.

Compressed air for the Utex Co. is supplied by a skid-mounted, Ingersol-Rand, Gyro-flo 600, rotary compressor. The G & G Co. has two 210-c.f.m. Le Roi Air Master compressors, interconnected by a popoff system.

The well-equipped shop makes it possible to make most repairs of equipment at the mine.

ORE PRODUCTION

From December 1952 to July 15, 1953, ore production from the Utex mine, as reflected by ore-settlement sheets received by the Utex Exploration Co., totaled about 16,000 short tons (see table 1) averaging 0.51 percent U_3O_8 and 1.26 percent V_2O_5. About 4,400 tons or 27 percent of the total contained 3 percent or less $CaCO_3$. The remainder (11,600 tons or 73 percent of the total) averaged 12.26 percent $CaCO_3$, and the $CaCO_3$ content ranged from 4.1 to 19.8 percent. Ore shipments by the lessee, G & G Mining Co., during the period represented about 41 percent of the total and averaged 0.59 percent U_3O_8, 1.21 percent V_2O_5, and 14.90 percent $CaCO_3$.

TABLE 1. — Production of Utex mine, December 1952 to July 15, 1953, as recorded on ore-settlement sheets

Month	Ore shipped, dry short tons	U_3O_8 content, pounds	V_2O_5 content, pounds	Grade of ore, percent U_3O_8	Grade of ore, percent V_2O_5
December 1952	16.204	192	734	0.59	2.26
January 1953	554.184	3,729	13,097	0.34	1.18
February	1,329.921	15,322	46,094	0.58	1.73
March	1,678.998	16,203	50,175	0.48	1.49
April	1,988.099	21,527	57,415	0.54	1.44
May	2,374.934	22,474	53,446	0.47	1.13
June	4,864.394	50,804	111,243	0.52	1.14
July 1-15	3,161.765	32,331	68,619	0.51	1.09
Total	15,968.499	162,582	400,823	0.51	1.26

Ore is transported by trucks from the mine over a winding 8.8-mile road down the bottom of Steen Canyon in a generally southwest direction to U. S. Highway 160 and thence (1) 25 miles south over U. S. Highway 160 to the ore-buying station at Monticello, Utah, operated by the American Smelting & Refining Co. for the Atomic Energy Commission; (2) 69.6 miles

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northwest over U. S. Highway 160 to the ore-buying station at Thompson, Utah, operated by the United States Vanadium Co.; or (3) 69.6 miles to Thompson and thence 82 miles east over U. S. Highway 50 to the plant of the Climax Uranium Co. at Grand Junction, Colo.

Settlements for the ore are made by the purchasing companies on the basis of the price schedule, bonus, and allowances set forth in Revised Circular 5 issued by the Atomic Energy Commission.

As indicated by the production statistics, the Utex mine reached the position of a 2,000-ton shipper of relatively high-grade uranium ore in the short period of 4 months. This is an outstanding achievement in the region and may be attributed to discovery of an unusual ore body and to its prompt development by the Utex Exploration Co.

Interior - Bureau of Mines, Pittsburgh, Pa.

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